M/045/017

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DIVISION OF OIL, GAS & MINING

October 11, 1990

Mr. Glen Eurick
Environmental Affairs Coordinator (USA)
Barrick Mercur Gold Mine
P.O. Box 838
Tooele, Utah 84074

RE: **Notice of Deficiency**: July 30, 1990 Dump Leach No. 3 Hydrogeologic Report; Ground Water Quality Discharge Permit No. UGW450001

Dear Mr. Eurick:

We have reviewed the above referenced report.

As you recall, Part I H(3) of your permit required, among other things, that the Hydrogeologic Report demonstrate that the monitoring well network meets or will meet the requirements of Part I E(2) of the permit. It is our determination that the report, has failed to show that the existing monitoring well network meets the permit requirements; nor has it provided a compliance schedule by which said requirements will be met.

Please review the attached comments and prepare a detailed plan and compliance schedule by which Barrick will demonstrate that the monitoring well network meets the requirements of Part I E(2) and H(3) of your permit.

Please be advised that in accordance with Part I E(2)(f) and H(3) of the permit, Executive Secretary approval of both the compliance monitoring well network and the Hydrogeologic Report is required <u>before</u> application of lixiviant on Dump Leach No. 3.

If you have any questions or comments, please call Loren Morton at 538-6146.

Sincerely,

Utah Water Pollution Control Committee

Don A. Ostler

Don A. Ostler, P.E.
Executive Secretary

attachment

cc: Fred Nelson, Asst. Attorney General
Wayne Hedberg, DOGM
Matt Trujillo, Tooele County Health Dept.
Terry VanDell, Dames & Moore

LBM:kc
Q:BMD3HGR.LTR

October 11, 1990

Bureau of Water Pollution Control Comments on:

Site Hydrogeologic Report for Dump Leach Area #3
Barrick Mercur Gold Mine, Utah
for
Barrick Resources (USA), Inc.
by
Dames & Moore, Salt Lake City

1. Section 4.1 Local Geology (p.5) -

   a) Plate 2 Errors - major errors exist on Plate 2 which have significant impact on the hydrologic interpretation for the site, these include:

      1) Fault Throw - the throw on all the faults on cross-sections A-A' and B-B' do not correspond with the throws shown on the site geologic map (compare Plates 1 and 2).

      2) Fault Block Error on Section B-B' - the west side of the Meadow Canyon Fault is upthrown on Plate 1, not downthrown as depicted on section B-B'. This upthrown relationship with 80 feet of reported displacement (p.7) causes well MW-11 to be separated from the permanent process pool by a block of Long Trail Shale. Well MW-11 is therefore not directly downgradient of the permanent process pool, as indicated on section B-B'.

      3) Meadow Canyon Fault - both sections show the Meadow Canyon Fault to be vertical, when its trace on the geologic map indicates that is inclined.

      4) Failure to Project Contact Downdip - Formational contacts from boring CD-7 have been projected onto Section B-B' as if the formations were horizontal, when in fact outcrops on the same fault block have been observed with easterly dips of 32 to 40 degrees. This error has resulted in projections of the contacts at least 98 feet too high on the section. Proper projection of these contacts downdip onto section B-B' reverses the plunge of the Long Trail Shale to the south. This indicates that downgradient compliance monitoring wells will need to be located to the south and east of the site in order to find a downgradient location. For your information, proper projection of these contacts causes the plunge of the Long Trail Shale in the section to be consistent with the regional plunge of the Ophir Anticline (compare with Section C-C', Tooker, 1987, USGS Open File Report 87-152).

5) East-West High Angle Fault South of MW-11 - no explanation has been provided on why the east-west fault immediately south of well MW-11 is vertical and not south dipping, as mapped by the USGS (Tooker, 1987, Sheet 2).

6) Minor Errors in Hanging Well Logs on Sections - wells that occur on the plane of the section should be hung so that the top of the log intersects the topographic profile. This effects boring Y-30 on Section A-A' and well MW-11 and boring Y-30 on Section B-B'.

Also, horizontal projection of well MW-12 up-strike onto section A-A' places it approximately 50 feet farther west than its depicted location.

b) Plate 3 Errors -

1) Structural Contours on Long Trail Shale - because the Ophir Anticline plunges to the south, the 6800, 6600, and 6400 feet contour lines should be parallel to strike or curve west, instead of curving east (unless truncated by a vertical fault).

2) Permanent Process Pool - the location of the permanent process pool should be added to the drawing to aid in interpreting its relationship to the monitoring wells.

3) Known Potentiometric Contours - an adequate downgradient compliance monitoring well network will be justified by known potentiometric contours and elevations. Suspect or inferred contours are not adequate for this purpose.

4) East-West Fault South of MW-11 - the fault occurs in two segments on Plate 3, while on Plate 1 it is shown as unsegmented. This may repeal the extension or displace the trace of the 6400 foot potentiometric contour north of the fault, shown on Plate 3.

5) Location of MW-11 in Local Flow System - the location of this well in the local ground water flow system must be shown with known potentiometric contours, in addition to other data herein cited, before it can be accepted for downgradient compliance monitoring.

6) Manning Canyon Thrust - if the thrust forms a ground water flow boundary, as labeled, the regional potentiometric contours must eventually terminate into the thrust at right angles. However as shown on Plate 3, the potentiometric contours are parallel to the thrust fault, indicating it does not form a no-flow boundary. No explanation for this apparent contradiction has been provided.

2. Section 5.1.1 Recharge (p.8) - precipitation falling on the Upper Member of the Great Blue Formation in the Dead Horse Canyon drainage and on outcrops to the west may also contribute recharge to the bedrock aquifer in the vicinity of Dump No. 3.

3. Section 5.1.3 Saturated Zones (p.11) -

   a) Dominant Joint Pattern on Figure 4 - if the dominant joint set shown (N, 20°E to N, 50°E with dips of 80-90° NW) is projected onto well MW-11 it is apparent that such joints would not intercept the permanent process pool in Dump 3. The same is true even if similar joints intercepted by the screened interval are projected to the surface. Based on these joint projections, it appears infeasible that MW-11 could be used for downgradient compliance monitoring.

   b) Conjugate and Orthogonal Joint Patterns - contrary to Figure 4, joint patterns shown on the geologic map (Plate 1) suggest conjugate and orthogonal joint pairs exist in the immediate vicinity of Dump 3. Conjugate joint pairs have been observed on three outcrops within 700 feet south and southeast of Well MW-10, and orthogonal joint pairs on one outcrop south of MW-12 (within 380 feet) and on two outcrops north of MW-12 (within 650 feet). As a result, the flow system may be controlled by joint pairs producing a dominant ground water flow tensor which is not aligned with only one joint system, but is a function of the characteristics of a joint pair. A more detailed analysis may be needed to show that the orientation of the local joint pairs, and their relative porosities and permeabilities produce a local ground water flow regime in which MW-10 is hydraulically downgradient of the permanent process pool. Barrick may also install additional monitoring wells to demonstrate the local ground water flow field. In any case, additional work is needed to demonstrate that MW-10 is an adequate downgradient compliance monitoring well.

   c) Meadow Canyon Fault - If the fault has higher porosity and permeability than the nearby jointed bedrock and because it directly underlies the dump leach site, it may form an important conduit for ground water flow and downgradient compliance monitoring. Its importance for ground water monitoring will only be known when the horizontal limit of saturation in the Upper Member of the Great Blue Limestone Formation is known south of the dump leach site.

4. Section 5.2 Hydrogeologic Characteristics (p.12) -

   a) Reported Flow Directions - based on the errors in the cross-sections cited above, the orientation and relationship of joint sets on the site, the unknown influence of the Meadow Canyon Fault on the local flow system; the northeast ground water flow direction stated in the report is inconclusive and without adequate foundation.

b) Historic Water Level Data and Local Flow Directions - in a complex hydrogeologic terrain such as this, historic water level data is only useful in determining locations for the first round of monitoring well installations. For the purposes of compliance monitoring, Barrick must document the local flow directions with actual water level data collected concurrently from all the wells on the site. This will require the installation of more monitoring wells in the vicinity of Dump 3. Access to actual water level data in these wells will allow Barrick to document the local ground water flow direction and adequacy of the downgradient compliance monitoring wells during future operation, closure and post-closure monitoring of the dump leach. It is the intent of the permit and of the Executive Secretary to periodically review the future water level data to assess local flow direction and adequacy of the downgradient monitoring wells. Without access to this information the Executive Secretary cannot determine future adequacy of the monitoring well network as required by Part I E(2) and (3) of the permit.

c) Hydraulic Gradient - accurate hydraulic gradients can only be calculated once equipotentials and flow directions are determined.

d) Vertical Hydraulic Gradient - vertical gradient will need to be determined in order to adequately locate the horizontal and vertical location of the downgradient compliance monitoring wells. This will require installation of nested monitoring wells or piezometers to determine the vertical hydraulic gradient.

e) Compliance Monitoring Well Numbers and Locations - the numbers and locations of downgradient compliance monitoring wells must be determined after consideration of: 1) current ground water flow directions, both horizontal and vertical, in conjunction with the relative location of the permanent process pool; with emphasis on the deepest part of the process pool, and 2) the degree of dispersion of any leachate released from the leach dump into the ground water flow system, i.e., the narrower the potential contaminant plume the closer the spacing and the greater the number of downgradient monitoring wells needed. The only exception to this second factor would be if the potential contaminant pathway were known with a high degree of certainty, then a close spacing of wells may not be necessary.

f) Absence of Ground Water in MW-12 (p.13) - because aquifers are commonly recharged at the outcrop, the lack of ground water in well MW-12 could also be explained by the well's failure to encounter conductive fractures, the episodic or seasonal nature of recharge, or by any number of other explanations.

g) Hydraulic Gradient Between Wells MW-10 and 11 - the small hydraulic gradient between these two wells may be only an apparent gradient if they are not completed in the same ground water flow system. Several factors indicate the wells may not be located in the same flow system; these are:

1) The wells set on opposite side on an east-west fault, which may form a no-flow boundary.

2) The major ion chemistry of the ground water is different in each of the wells, based on the average concentration of the samples collected. Well MW-10 encountered a predominantly sulfate ground water with an average TDS of 1183 mg/l, while MW-11 encountered a predominantly bicarbonate ground water with an average TDS of 637 mg/l.

3) The ground water elevations measured in the wells show that the head in well MW-10 has consistently been higher than those measured in MW-11, yet MW-11 produces ground water with a lower TDS concentration; approximately one-half of the total dissolved solids found in MW-10. It would appear that if the two wells were hydraulically interconnected that solute mass would have been transferred by advection and dispersion from the area of MW-10 to the vicinity of MW-11, changing both the major anion chemistry and TDS in MW-11.

4) The pump test of Well MW-11 encountered a no-flow boundary at approximately 28 minutes into the test, as evidenced by the doubling of the time-drawdown slope.

5) Interconnection is unknown because water level response data from pump tests has only been provided from the pumped well. No water level measurements have been provided from an observation well during a pump test, i.e., from MW-10 during pumping of MW-11, or vice versa.

h) Hydrogeologic Cross Sections and Potentiometric Maps for Multiple Aquifers - if more than one aquifer is identified by Barrick, additional cross-sections must be prepared, which meet the requirements of Part I H(3)(d) of the permit. The potentiometric surface of each uppermost aquifer must also be contoured in accordance with Part I H(3)(c) of the permit.

5. Section 5.3 Hydrogeochemical Description (p.13) -

a) Protection Level Exceedances - the April 11, 1990 sample from MW-10 also exceeded the permit's protection level for nickel.

b) Major Ions in MW-10 - ground water found in well MW-10 contains sulfate as the predominant anion, contrary to the statement on page 14 that both wells contain bicarbonate type ground water (compare ground water analyses in Appendix C).

c) Local Variations in Ground Water Quality - local variations in ground water quality could also be explained by differing flow paths, sources of recharge, or local variation in aquifer mineralogy. However, if the ground water quality "compartments" are hydraulically connected, one would expect that advective transport and/or Brownian ion diffusion would have caused a chemical equilibrium to develop in the system, especially considering the small local scale of flow system and the several millions of years the flow system has existed. An adequate compliance monitoring well network will fully explore and explain this ground water quality differential. If the local flow system is segregated into separate ground water flow compartments by local geologic structure, it will be imperative to identify the number, extent, and locations of these compartments, their relative location to the permanent process pool, and the hydrologic conditions within them, in order to provide an adequate downgradient compliance monitoring well network.

d) Hydrochemical Facies - Part I H(3)(e) of the permit requires that all hydrochemical facies identified in the Hydrogeological Report be keyed to the potentiometric map. The local variations in ground water quality should be identified on Plate 3 with stiff or other hydrochemical diagrams.

6. Section 6.0 Ground Water Monitoring Network (p.16) -

a) Shallow Alluvial/Colluvial Monitoring Well - Hydraulic conductivity and distribution thereof in the alluvium is unknown, and unaccessible due to waste rock fill emplacement. Comparison of the hydraulic conductivity estimates provided for the alluvium/colluvium (p.9) and from the deep bedrock pump tests in wells MW-10 and 11 (p.10) show the permeabilities to be near equal. However, after consideration that the site in on the flank of an anticline, it is clear that the fractures intercepted at depth in the wells become more open or have larger apertures at outcrop or shallow subcrop. This effectively makes the bedrock beneath the dump leach more permeable than the alluvium; perhaps by as much as several orders of magnitude. Due to the unsaturated nature of the alluvium and the lack of a low permeability perching mechanism beneath it, a leachate may be released from the dump and seep through the alluvium and into the bedrock, undetected by the alluvial monitoring well. Such a phenomenon by a monitoring well is called a false negative response, and is not acceptable for the purpose of compliance monitoring.

b) False Negative Response in a Monitoring Well Network - it is Barrick's responsibility to demonstrate that the compliance monitoring well network is not susceptible to a false negative response or condition. This can only be accomplished after a clear understanding and documentation of the local hydrogeologic conditions and flow system.

c) Potential for Contamination to Reach Ground Water - the cyanide attenuation studies referred to on page 17 may not apply to vadose zone attenuation beneath Dump 3 for the following reasons:

1) The studies conducted were based on flow through a porous media. Such flow provided long contact time and a large surface area to fluid volume ratio. Such conditions will probably not be duplicated in the fractured dominated carbonate media below Dump No. 3.

2) The laboratory tests were conducted under highly controlled conditions of known flow rate, temperature, and shale mineralogy. Like conditions may not exist below Dump 3.

7. Appendix A. Field Investigations and Monitor Well As-Built Construction Reports

a) Backfill Material - Barrick must disclose what type of material used to backfill overdrilled segments in wells MW-10 and 11.

b) Sand Pack - the length of borehole filled with sand pack should be limited to within a few feet of the screen length. This will be critical in wells used to define vertical hydraulic gradients.

c) Well Development - did well development continue until purged water achieved a turbidity of 5 NTU?

d) Geologic Logs - what lithologic or other properties make the Long Trial Shale distinct from the minor shale beds in the Upper Member of the Great Blue Limestone?

8. Appendix B. Aquifer Pump Test Data

a) Discharge Rate - how was the discharge rate controlled during the pump est? What variance was experienced in the rate during the pumping test?

b) Fracture Flow - Barrick must justify how the Theis derived solutions used to analyze the pump test results describe fracture flow of the local flow system or use other solutions which adequately describe the drawdown response of a fracture dominated flow system.

c) Confined System - Barrick must provide evidence to show that the bedrock aquifer is a confined system or use a solution which adequately describes the time-drawdown response of an unconfined system. If the confined solution used is adequate, the large drawdown in MW-11 will require correction of the data to determine true hydraulic conductivity.

d) Partial Penetration - partial penetration of well MW-11 will make the hydraulic conductivity results minimum values. Actual permeability is likely higher than the values measured.

e) Figure B-3 - the slope of the hydrologic boundary encountered by Well MW-11 more than doubles at approximately 28.8 minutes into the test. This indicates a no-flow boundary was encountered, not a low flow boundary. Additionally, if the system is confined and adequately described by the Theis assumptions, the no-flow boundary is located at a great distance from Well MW-11 when one considers that a pressure decline response in a confined aquifer is propagated at nearly the speed of sound (1,100 ft/sec). If the east-west fault south of well MW-11 forms the no-flow boundary then the system must necessarily be unconfined.

9. Appendix C. Ground Water Quality Data

a) Date of Analysis and Holding Time - the date of analysis must be included for each parameter in the analytical report, so that the adequacy of holding times and analysis results can be established. The June 13, 1990 sample from MW-11 failed the 48 hour holding time requirement for nitrate, in that it wasn't submitted to the laboratory until June 17, 1990 (see chain-of-custody sheet).

b) Missing Nitrite Analysis - no nitrite analysis was reported for some samples from MW-10 (April 11, 1990, April 19, 1990, June 12, 1990) and MW-11 (April 18, 1990, June 13, 1990).

c) Missing Chain-of-Custody Forms and Field Sampling Logs - no chain-of-custody forms or field sampling forms have been submitted for the June 27, 1990 sampling of MW-11 and the June 28, 1990 sampling of MW-10.

d) Field Sampling Log Error for MW-10 - the June 12, 1990 field log erroneously calculated three casing volumes to be 374.7 gal when it was 959 gallons. Also, the log failed to identify how many gallons of water were actually purged before sampling took place.